ARTICLE I

STREETS

SECTION 1.1 General

Design Standards

1. The purpose of this section is to establish minimum standard criteria, principles, procedures and practices for design of rigid and flexible pavements and is not to replace the independent judgement and responsibility of the design engineer.

2. The design factors, formulas, graphs and procedures presented or referred to herein are intended for use as minimum engineering guides in the design of rigid and flexible pavements.

3. Methods of design other than those indicated or referred to herein may be considered in complex and difficult cases where experience clearly indicates they are preferable; however, these deviations shall not be attempted until approval has been obtained from the City Administrative Officer or his duly authorized designee. If existing conditions are determined that require greater than the minimum design, it is the responsibility of the design engineer to design accordinaly.

4. The methods outlined or referred to herein include accepted principles of pavement thickness design and should be a working supplement to basic design information obtainable from text books and publications on pavement design.

5. The engineer responsible for the design of the proposed improvmenets shall submit testing reports performed by the Engineer of an independent testing laboratory with a verification statement to the City Administrative Officer that the improvements have been constructed in accordance with the plans and specifications.

SECTION 1.2 Rigid Pavement

Rigid Pavement Thickness Design Procedure - The pavement thickness shall be designed as simply reinforced concrete pavements.

Flexural Strength of Concrete - Flexural strength of concrete (modulus of rupture, MR) is applicable in design procedure for fatigue criterion, which controls cracking of pavement under repetitive truck loadings. A design MR of 550 psi and a concrete compressive strength of 3,000 psi at 28 days shall be used in the rigid pavement thickness calculations.

Subgrade Support - The subgrade support given to concrete pavements is defined as the modulus of subgrade reaction (k) in psi per inch and shall be used in the design of the concrete pavement thickness. To determine the modulus of subgrade reaction (k), the developer's engineer shall furnish the following information along with the pavement thickness calculations.

1. The developer shall have an independent soil laboratory approved by the City, sample the subgrade soils to determine the major soil classifications based on the unified Soil Classification System as defined in ASTM D-2487.

2. Samples shall be taken at least once per block or every 500 feet, whichever is less, with a minimum of three (3) samples per project.

3. The developer's engineer may use the assigned California Bearing Ratio (CBR) values listed below for the soil classifications, in lieu of performing the CBR tests.

ASSIGNED CBR VALUES

Soil Classification	CBR Value
CH	3 (If PI = 30 modify)
CL	6
SC	12
SM	12
SP	15
ML	6
SW	20
GC	20 for -200 < =15% 12 for -200 < =20%
GM	20 for -200 < =15% 12 for -200 < =20%
GP	25
GW	30

4. When CBR tests as determined by ASTM D-1883 are performed on each classification of the raw subgrade soil, and when only one CBR test is performed, the CBR value shall be reduced by 20%. If two (2) CBR tests are performed, the average of the two CBR tests shall be reduced by 10%. If three (3) or more CBR tests are performed, the average of the CBR values shall be used.

   For dual classifications (CL, CH), use the assigned CBR value of single classification which results in the lower CBR, or perform CBR tests.

   Where a higher CBR soil overlies a lower CBR soil, the higher CBR value shall not be used unless the higher CBR soil will have a minimum thickness of twenty-four (24) inches in the prepared subgrade.

5. Soil stabilization under concrete pavements shall not be required if the CBR of the soil is five (5) or greater. The subgrade shall be scarified to a depth of eight (8) inches and recompacted to no less than 100% of maximum dry density with a moisture content within two (2) percentage points dry to three (3) percentage points wet of optimum moisture content, as determined by ASTM D-698, Standard Proctor.

6. Soil stabilization shall be required under concrete pavements if the CBR of the subgrade soil is less than five (5). A minimum of six (6) percent lime or cement shall be used to modify the subgrade soil. The top eight (8) inches of the subgrade soil shall be stabilized. This eight (8) inch lift of stabilized soil may be assigned a maximum CBR value of 20.

   At the developer's option, CBR tests may be performed on the subgrade soils with the six (6) percent lime or cement as determined by ASTM D-3668. If only one CBR test is performed, the CBR value shall be reduced by 20%. If two (2) CBR tests are performed, the average of the two CBR tests shall be reduced by 10%. If three or more CBR tests are performed, the average of the CBR values shall be used.

   The stabilized subgrade shall be recompacted to no less than 100% of maximum dry density with a moisture content within two (2) percentage points dry to three (3) percentage points wet of optimum moisture content, as determined by ASTM D-698, Standard Proctor.

7. The in-place density of all classifications of compacted earth fill shall be no less than 95% of maximum dry density as determined by ASTM D-698, Standard Proctor, the exception

being the top twelve (12) inches of fill underneath roadways. This earth fill shall be compacted to no less than 100% of maximum dry density with a moisture content within two (2) percentage points dry to three (3) percentage points wet of optimum moisture content, as determined by ASTM D-698, Standard Proctor.

Geotextile - Soil Stabilization - The geotextile shall be a nonwoven fabric consisting only of continuous chain polymer filaments or yarns of polyester, formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew and rot resistant, resistant to ultraviolet light exposure, insect and rodent resistant, and conform to the properties in Table 1.1. The average roll minimum value (weakest principle direction) for strength properties of any individual roll tested from the manufacturing lot or lots of a particular shipment shall be in excess of the average roll minimum (weakest principle direction) stipulated herein.

Geotextile shall be TREVIRA S1125, Quline Q100 or approved equivalent.

The geotextile shall be installed on the prepared subgrade. Overlaps, when necessary , shall be thirty-six (36) inches minimum. The aggregate shall be back dumped onto the fabric and spread in a uniform lift always maintaining the design aggregate thickness. Construction vehicles will not be allowed to traffic directly on the fabric.

Overstressing the soil shall be avoided by using equipment in spreading and dumping that exerts only moderate pressures on the soil. Severe rutting at the time of placement is an indication of overstressing the soil. Such soil overstressing must be avoided. Increasing the aggregate depths and reducing loads are two methods of reducing the pressures on the soil.

Any ruts which develop during spreading or compacting shall be filled with additional aggregate rather than blading from surrounding areas.

Table 1.1

Geotextile Test Requirements

Physical Properties (Weakest Principle Direction)	Average Roll Minimum Value
Grab Tensile Strength ASTM D1682 (Lbs.)	200
Elongation At Failure ASTM D1682 (%)	60
Mullen Burst Strength ASTM D3786 (PSI)	320
Water Flow Rate (gal/min/sq.ft.) (5 in. constant head) (ASTM D4491)	100
Apparent Opening Size (A.O.S.) (U.S. Standard Sieve No.) CW-02215 U.S. Std. Sieve Number larger than	70
Trapezoid Tear Strength ASTM D1117	60
Puncture Strength ASTM D751 (modified) Lbs.)	80

Subgrade Drainage - Providing for subgrade drainage is imperative for a successful pavement design, whether the pavement is flexible or rigid. The pavement design section includes elements to provide subgrade drainage. A geotextile shall be used in conjunction with a six-inch uniform graded crushed stone aggregate base (drainage course) for subgrade drainage. The geotextile will also provide separation, reinforcement and filtration for the subgrade.

The geotextile shall be placed between the subgrade and drainage course. The geotextile separates these two courses, preventing the aggregate from being lost by intrusion down into the subgrade and preventing the soil fines from pumping up into the aggregate base. The geotextile will also provide additional reinforcement to the subgrade by spreading the load over the subgrade and confining the aggregate in the base course. The filtration function of the geotextile acts to allow free flow of water, normal to the plane of the fabric, from the subgrade into the aggregate base course. This allows the flow of water out of the pavement structure while preventing the loss of soil from the subgrade. The geotextile also supplements the aggregate base course in draining water out of the pavement structure by allowing free water flow in the plane of the fabric while preventing loss of soil from the subgrade. The basis for the use of geotextiles in pavement structures is presented in "Design of Flexible Pavements with Geotextiles", (Ref. 2), which is also applicable to rigid pavements constructed on crushed stone drainage courses.

Drainage Course - One of the following standard aggregate gradations, ASTM D-448 size No. 57 or No. 67, shall be used as the drainage course. The drainage course thickness shall be six (6) inches. When a drainage course is required, a geotextile shall be used.

The aggregate drainage course shall be placed in one lift over the geotextile. The drainage course shall receive a minimum of eight (8) passes with a 10 ton, steel-wheeled vibratory roller. The drainage course requires rolling for density and stabilization but does not require specific compaction criteria.

No aggregate drainage course shall be required when the subgrade has a Unified Soil Classification of GW, GP, SW or SP, provided the subgrade has a means of draining to daylight or is significantly thick.

Composite CBR Value - The CBR value to be used to determine the modulus of subgrade reaction (K) value shall be the composite CBR value. The composite CBR for rigid pavement shall be determined as follows:

1. Condition No. 1. - Raw subgrade CBR value greater than five (5).

   A maximum CBR value of sixty 60 shall be assigned to the six (6) inch thick drainage course.

   The raw subgrade CBR or Geomod CBR value (Geomod CBR, as determined in Total Pavement Thickness Design in Section 1.3, the raw subgrade CBR is ten (10) or less) shall be multiplied by three (3) and this value added to the drainage course CBR value of 60 and divided by two (2) to obtain the composite CBR value.

2. Condition No. 2 - Raw Subgrade CBR value is five (5) or less.

   The raw subgrade CBR is multiplied by two (2), then added to the stabilized subgrade CBR of twenty (20), (or CBR value obtained from actual CBR tests) and divided by two (2). This value shall be multiplied by three (3) and shall be added to the drainage course CBR of sixty (60) and divided by two (2) to obtain the composite CBR value. When an aggregate drainage course is not required, the Composite CBR shall be the CBR of the raw subgrade as determined above, without the multiplier of three (3). The CBR value of the subgrade soils shall be correlated to the modulus of subgrade reaction (k) in psi per inch. Approximate values of (k) can be obtained from Figure 2, in Portland Cement Association's (PCA) publication, "Thickness Design for Concrete Highway and Street Pavements", (Ref. 1). If the composite CBR is greater than sixty (60), the modulus of subgrade reaction (k) value to be used shall be 600 psi.

Design Period - The design period shall be 20 years. The intersections of two (2) major collectors, two (2) minor arterials, a major collector and a minor collector and a major collector and a minor arterial shall be designed for 40 years.

Traffic - The average daily truck traffic (ADTT) shall be estimated as outlined in the PCA publication, "Thickness Design for Concrete Highway and Street Pavements", (Ref. 1) and used to design the pavement thickness for major and minor collector streets and minor arterial streets. The volume of truck traffic anticipated for a local street shall be based upon twice the number of solid waste truck trips expected during the design period. The number of truck trips is defined as the number of times during the design period that the solid waste is collected for a residence located on the local street being designed, (i.e., two collections per week for 20 years equals 2,080 truck trips). A twenty (20) kilo pound (kip) single axle load with dual wheels shall be used for the solid waste trucks when designing the pavement thickness of the local streets.

Subdrainage System for Roadways - All roadways with storm drain collection systems shall provide for subgrade drainage as follows:

The drainage aggregate for the subdrains shall be the same aggregate as specified for the drainage course.

The geotextile shall be specified above for Geotextile - Soil Stabilization.

The drainage pipes shall be a minimum of four (4) inches in diameter, sized for flow rates of 0.025 cfs per 1000 square feet of pavement surface due to infiltrate. Clean outs shall be installed at a maximum of 250 feet intervals. The drainage pipes shall connect to stormdrain systems or drainage channels at maximum intervals of 500 feet.

The pipe, fittings and connections shall be PVC conforming to ASTM D-17894 and D-2241, 160 psi rating. All joints and fittings shall be rubber gasket type.

The perforated drainage pipe shall have 3/8 inch diameter holes at four inches on center in two rows, one on either side of the vertical centerline, and shall be separated on the bottom of the pipe by an arc of 120 degrees.

The drainage aggregate shall be compacted in four inch layers with a vibratory plate power hand compactor. Each lift shall be compacted with a minimum of eight passes of the compactor.

The drainage pipe shall be installed in conjunction with the drainage aggregate in such a manner that will prevent damage to the pipe and will not interfere with compaction of the aggregate. Prior to installation, the vertical centerline shall be marked on the top of each section of perforated pipe, with a waterproof felt-tipped marker or other suitable device, to facilitate verification that the perforations are properly oriented. Fittings of the proper type shall be provided at all bends and junctions in the drainage pipe.

All roadways which require an aggregate drainage course and do not contain a storm drain collection system shall provide subgrade drainage as follows:

> The geotextile and aggregate drainage course shall "daylight" at each existing drainage-way along the proposed roadway.

Pavement Thickness Design - All concrete street pavement thickness shall be designed for simply reinforced concrete pavements. The procedures outlined in the PCA publication, "Thickness Design for Concrete Highway and Street Pavements", (Ref. 1) shall be followed. The Design Factors noted above shall be used when determining the concrete pavement thickness.

Joint Design - Joints are required in rigid pavements to allow for expansion of the slab, reduce the stresses and cracking caused by warping, reduce the amount of shrinkage cracking and provide a means of interim termination of the concrete placing operation during construction. Accordingly, expansion joints, longitudinal contraction (warping) joints, transverse contraction joints and construction joints shall be required. General joint details are shown on the attached plates.

1. **Expansion Joints** - Expansion joints shall be provided at intersections, where the pavement abuts a structure and otherwise at intervals not to exceed 600 feet.

2. **Longitudinal Contraction (Warping) Joints** - Longitudinal contraction shall be provided at approximately each twelve (12) feet of pavement width or between lanes. These joints generally shall be of the saw-cut (dummy) joint type similar to those shown on the attachments except where wide pavements require the use of longitudinal construction joints.

3. **Transverse Contraction Joints** - Transverse contraction joints shall normally be placed at intervals approximately equal to the pavement width. No bonded reinforcement shall extend across transverse contraction joints. Saw-cut dowelled transverse contraction joints as shown on the attached plates shall be used.

4. **Longitudinal Construction Joints** - Longitudinal construction joints shall be required where the pavement width exceeds twenty-four (24) feet. These joints shall be tied with deformed tie bars as shown on the attachments.

5. **Transverse Construction Joints** - Transverse construction joints shall be minimized. The pavement shall be placed in one pour between expansion joints, where practical, with transverse construction joints being used only for emergency termination of the pavement placing operation. Transverse construction joints where unavoidable shall be used in place of a transverse contraction joint. Typical construction joint details are shown on the attached plates.

6. **Smooth Steel Dowels** - Smooth steel dowels shall be used for load transfer devices at expansion and contraction joints. The dowels shall be designed as outlined in Principles of Pavement Design" by E.J. Yoder and M.W. Wiczak, (Ref. 3). The length of dowel embedment in the concrete shall be nine (9) inches.

Reinforcing Design - Distribution reinforcement in the transverse and longitudinal direction shall be designed as outlined in, "Principles of Pavement Design" by E.J .Yoder and M.W. Wiczak, (Ref. 3). Typical reinforcement details are shown on the attached plates.

SECTION 1.3 Flexible Pavement

Flexible Pavement Thickness Design Procedures - The pavement thickness shall be designed for an improved subgrade CBR value of not less than seven (7) and the probable truck traffic anticipated during the design period.

Subgrade Support - The composite CBR value shall be used to determine the load carrying capacity of the subgrade. The developer's engineer shall furnish the subgrade soil information described above, under Subgrade Support for Flexible Pavement, along with the pavement thickness calculations.

The developer may select to stabilize the raw subgrade with a minimum of six (6) percent lime or cement to modify the subgrade soil. The top eight (8) inches of the subgrade soil shall be stabilized. this eight (8) inch lift of stabilized soil may be assigned a maximum CBR value of twenty (20).

At the developers option, CBR tests may be performed on the subgrade soils with the six (6) percent lime or cement as determined by ASTM D-3668. If only one CBR test is performed, the CBR value shall be reduced by 20%. If two (2) CBR tests are performed, the average of the two CBR tests shall be reduced by 10%. If three (3) or more CBR tests are performed, the average of the CBR values shall be used.

The stabilized subgrade shall be recompacted to no less than 100% of maximum dry density with a moisture content within two (2) percentage points dry to three (3) percentage points wet of optimum moisture content, as determined by ASTMN D-698, Standard Proctor.

When the subgrade soil is stabilized, a composite CBR value shall be determined as follows:

> The raw subgrade CBR is multiplied by two (2) then added to the stabilized subgrade CBR of twenty (20), (or CBR value obtained from actual CBR tests) and divided by two (2) to obtain the composite CBR value. The composite CBR is used to determine the Total Design Thickness from Figure 2 in Appendix B, as described later in Total Pavement Thickness Design.

Design Period - The design period shall be twenty (20) years.

The intersections of two (2) major collectors, two (2) minor arterials, a major collector and a minor collector and a major collector and a minor arterial shall be designed for minor arterial traffic loadings and frequencies.

Traffic - Traffic counts by vehicle type shall be used when available. The vehicle types shall be grouped as follows:

Group 1 - Passenger cars, panel and pickup trucks.
Group 2 - Two-axle trucks loaded or larger vehicles apparently carrying light cargoes.
Group 3 - Truck or combination vehicles having three, four, or more loaded axles.

Traffic count information on each vehicle type shall be converted to equivalent axle loads of 18 kips, (designated EAL), by using Figure 1, in Appendix B. Figure 1 was taken from the National Stone Association's FLEXIBLE PAVEMENT DESIGN GUIDE FOR ROADS AND STREETS, (Ref. 4).

When traffic count information is not available, Table 1.2 which defines six Design Index categories for traffic shall be used. The Design Index (DI) Numbers shown in Table 1.2 are based on descriptions in U.S. Army Technical Manuals and were taken from the National Stone Association's DESIGN GUIDE FOR PARKING AREAS, (Ref. 5).

Table 1.2

Design Index Categories for Traffic

Design Index	General Character	Daily EAL
DI-1	**Local Streets** - Light traffic (few vehicles heavier than passenger cars, no regular used by Group 2 or 3 vehicles).	5 or less
DI-2 & DI-3	**Minor Collector** - Medium traffic (maximum 3,000 VPD, including not over 10% Group 2 and 3, and 1% group 3 vehicles).	21 - 75
DI-4	**Major Collector** - Medium-heavy traffic (maximum 6000 VPD, including not over 15% Group 2 and 3, and 1% Group 3 vehicles).	76 - 250
DI-5	**Minor Arterial** - Heavy Traffic (maximum 6,000 VPD, may include 25% Group 2 and 3, and 10% Group 3 vehicles).	251 -900

Notes: EAL = equivalent 18 kip axle loads in design lane, average daily use over life expectancy of 20 years with normal maintenance.

VPD = vehicles per day, all types, using design lane.

Total Pavement Thickness Design - The National Stone Association (NSA) design method, outlined in DESIGN GUIDE FOR PARKING AREAS, (Ref. 5), shall be used to determine the total flexible pavement thickness. This method uses a thickness design chart, Figure 2 in

Appendix B, developed by the U.S. Army Corps of Engineers. The total design thickness of the pavement shall be selected from Figure 2 based upon the improved subgrade CBR and the traffic design index, and shall be a minimum of eight (8) inches. All flexible pavement structures shall include geotextile for soil stabilization, separation and filtration.

When the subgrade CBR is greater than ten (10), the Total Design Thickness selected from Figure 2 will be used to determine the pavement section.

When the subgrade is relatively weak (CBR between two (2) and ten (10), a geotextile for soil stabilization shall be used. The NSA method based upon the subgrade CBR and Traffic Design Index does not take into consideration the use of a geotextile for soil stabilization. An apparent improved CBR (Geomod) value can be determined from Figure 3 in Appendix B. Figure 3 was taken from DESIGN OF FLEXIBLE PAVEMENTS WITH GEOTEXTILES, (Ref. 2). The Geomod CBR value can be used to determine the total design thickness of the pavement with a geotextile, when the raw subgrade CBR is between two (2) and ten (10).

A Total Design Thickness with a geotextile for soil stabilization shall be selected from Figure 2 based upon the Geomod CBR and the Traffic Design Index.

Pavement Drainage - Proper internal drainage of the pavement structure is of utmost importance. The subgrade shall be graded for positive drainage to the roadway subdrainage system. The geotextile and aggregate base course shall "daylight" to drainage channels or subsurface drain systems which exit to stormdrain systems or a drainage-way. The aggregate base course is the total pavement thickness less the asphalt concrete surface course thickness. When the aggregate base thickness is eight (8) inches or more, it shall consist of a lower drainage course of uniform size free draining stone and an upper course of well-graded aggregate base material.

Subdrainage System for Roadways - All flexible pavement roadways shall provide for subgrade drainage as outlined in Subdrainage System for Roadways in Section 1.2.

Drainage Course - The drainage course serves two purposes; providing free flow of water out of the pavement structures and a working surface for protection and pre-tensioning of the geotextile. One of the following standard aggregate gradations, ASTM D-448 size No. 57

or No. 67 shall be used as the drainage course. The minimum drainage course thickness shall be five (5) inches when the total aggregate base thickness is eight (8) inches and a minimum of six (6) inches when the total aggregate base thickness is nine (9) inches or greater. A geotextile is required for all flexible pavement structures.

The aggregate drainage course shall be placed in one lift over the geotextile unless its design thickness is more than twelve (12) inches. The drainage course shall receive a minimum of eight (8) passes with a 10 ton, steel-wheeled vibratory roller. The drainage course requires rolling for density and stabilization but does not require specific compaction criteria.

No aggregate drainage course shall be required when the subgrade has a Unified Soil Classification of GW, GP, SW or SP, provided the subgrade has a means of draining to daylight or is significantly thick.

Well-Graded Aggregate Base (Flexible Base) - The well-graded aggregate base shall consist of a well graded, low P.I. crushed stone material. This aggregate shall have a maximum of twelve (12) percent passing the number 100 sieve by the wet sieve method to provide for better drainage. The "flexible base" gradation from the Texas State Department of Highways and Public Transportation, (Ref. 6) specification for Type A-Grade 1 material shall be used for the well-graded aggregate base. The well-graded base course provides a smoother, more cohesive surface which accommodates shaping to closer surface tolerances and provides a good surface for placement of the asphalt concrete surface course.

Placement of the well-graded aggregate base course shall follow immediately behind the aggregate drainage course. This course shall be rolled with a minimum of eight (8) passes with the 10 ton steel-wheeled vibratory roller and shall be compacted to a minimum density of 100% of maximum dry density, near optimum moisture content, as determined by ASTM D-1557, modified Proctor. Close observation and compaction control shall be performed.

Where the total design thickness of the aggregate base course is less than eight (8) inches, a single layer of well-graded aggregate shall be used. The well-graded aggregate will serve as the drainage course except when the subgrade has a unified Soil Classification of GW, GP, SW, or SP. Where the well-graded aggregate course serves as the drainage course, the gradation requirements shall be changed to allow a maximum of three (3) percent passing the number 100 sieve by the wet sieve method.

Aggregates retained on the number 4 sieve shall consist of durable, angular crushed stone particles and shall have a percentage of wear of not more than fifty (50) when tested in accordance with ASTM Method C-131 and a maximum of fifteen (15) percent loss when subjected to five (5) cycles of the sodium sulfate soundness test in accordance with ASTM Method C-88.

Where only one aggregate base course is used, the installation procedure shall proceed similar to that described above. If the composition of the aggregate base material is not suited for Proctor methods of density control, another recognized, acceptable method (such as percent of maximum theoretical density) shall be used. Any deformations in the surface of either aggregate base course which occur during placement shall be filled with additional aggregate during the compaction process rather than reblading aggregate into the depressions from the adjacent surfaces

Geotextile - Soil Stabilization - The geotextile shall be a nonwoven fabric consisting only of continuous chain polymer filaments or yarns of polyester, formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew and rot resistant, resistant to ultraviolet light exposure, insect and rodent resistant, and conform to the properties in Table 1.3. The average roll minimum value (weakest principle direction) for strength properties of any individual roll tested from the manufacturing lot or lots of a particular shipment shall be in excess of the average roll minimum (weakest principle direction) stipulated herein.

Geotextile shall be TREVIRA S1125, Quline Q100 or an approved equivalent.

The geotextile shall be installed on the prepared subgrade. Overlaps, when necessary, shall be thirty-six (36) inches minimum. The aggregate shall be back dumped onto the fabric and spread in a uniform lift always maintaining the design aggregate thickness. Construction vehicles will not be allowed to traffic directly on the fabric.

Overstressing the soil shall be avoided by using equipment in spreading and dumping that exerts only moderate pressures on the soil. Severe rutting at the time of placement is an indication of overstressing the soil. Such soil overstressing must be avoided. Increasing the aggregate depths and reducing loads are two methods of reducing the pressures on the soil.

Any ruts which develop during spreading or compacting shall be filled with additional aggregate rather than blading from surrounding areas.

Table 1.3

Geotextile Test Requirements

Physical Properties (Weakest Principle Direction)	Average Roll Minimum Value
Grab Tensile Strength ASTM D1682 (Lbs.)	200
Elongation At Failure ASTM D1682 (%)	60
Mullen Burst Strength ASTM D3786 (PSI)	320
Water Flow Rate (gal/min/sq.ft.) (5 in. constant head) (ASTM D4491)	100
Apparent Opening Size (A.O.S.) (U.S. Standard Sieve No.) CW-02215 U.S. Std. Sieve Number larger than	70
Trapezoid Tear Strength ASTM D1117	60
Puncture Strength ASTM D751 (modified) Lbs.)	80

Asphalt Concrete Surface Course - Asphalt concrete surface course thicknesses shown in Table 1.4 were taken from National Stone Association's FLEXIBLE PAVEMENT DESIGN GUIDE FOR ROADS AND STREETS, (Ref. 4). Table 1.4 presents the minimum hot mix asphaltic concrete surface course thickness based upon the Traffic Design Index.

The hot mix asphaltic concrete surface course shall comply in all respects to ITEM 340, "Hot Mix Asphaltic Concrete:, of the STANDARD SPECIFICATIONS FOR CONSTRUCTION OF HIGHWAYS, STREET, AND BRIDGES, as adopted by the STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION, (REF. 6), FOR TYPE "D".

All coarse graded binder course shall conform to Type "A", (Coarse Graded Base Course) as specified in the STANDARD SPECIFICATIONS FOR CONSTRUCTION OF HIGHWAYS, STREETS AND BRIDGES, (REF. 6).

Table 1.4

Hot Mix Asphaltic Concrete Thickness

Traffic Design Index	Hot Mix Asphaltic Concrete Thickness (inches)	
	Type "D" (Fine Graded)	Type "A" (Coarse Graded)
DI-1	1.5	___
DI-2	2.0	___
DI-3	1.0	1.5
DI-4	1.0	2.0
DI-5	1.0	2.5

An RC-2 prime coat shall be applied at the rate of 0.25 gallons per square yard to the aggregate base course prior to the placement of the hot mix asphaltic concrete.

A type RC-2 tack coat shall be applied to each layer of asphaltic concrete before the next layer is applied. The tack coat shall also be applied to any exposed concrete edges that will abut any hot mix asphaltic concrete. The tack coat shall be applied to each layer at a rate not to exceed 0.05 gallons per square yard of surface.

The hot mix asphalt concrete courses, including prime and tack coats, shall follow closely behind the completion of the aggregate base courses. The placement methods and density of the asphalt concrete shall be closely monitored and controlled by marshall density, or percent of maximum theoretical density. Compaction of the hot mix asphaltic concrete shall be as specified in ITEM 340 STANDARD SPECIFICATIONS FOR CONSTRUCTION OF HIGHWAYS, STREETS AND BRIDGES, (Ref. 6).

SECTION 1.4 Quality Control

Table 1.5 lists the types of tests and frequency that shall be performed by the testing laboratory approved by the City.

Table 1.5

Quality Control Testing Requirements

Area to be Tested	Frequency
Concrete Pavement	
Moisture and Density Tests Scarified and Recompacted Subgrade	Min. 3 per 500 feet
Compacted Earth Fill Subgrade	Min. 3 per 500 feet per 8 inch lift
Thickness Verification of Total Pavement Structure *	Min. 3 per 500 feet
Concrete Compressive Strength	3 per 50 C.Y. Min. 3 per day
Asphalt Concrete Pavement	
Moisture and Density Tests Scarified and Recompacted Subgrade	3 per 500 feet
Compacted Earth Fill Subgrade	Min. 3 per 500 feet per 8 inch lift
Moisture and Density Tests of Well-graded Aggregate Base (Flexible Base)	Min. 3 per 500 feet
Marshal Density of Asphaltic Concrete	Min. 3 per 500 feet
Thickness Verification of Total Pavement Structure *	Min. 3 per 500 feet

* Field observations during construction, conducted by City personnel, may be substituted in lieu of thickness verification tests.

SECTION 1.5 Pavement Widths and Right-of-Way Widths

Pavement Widths and Right-of-Way Widths - Pavement widths shall be measured from the back of one curb to the back of the other curb. The minimum widths of pavement and right-of-way shall conform to the adopted Comprehensive Plan; and pavement sections shall conform to the design details of the City. These widths are summarized in Table 1.6.

The alignment and design of streets should be such that collector streets have a safe running speed of 35 miles per hour, and residential streets have a safe running speed of 20 miles per hour.

Table 1.6

Minimum Widths of Paving and Right-of-Way

Street Classification	Minimum Paving Width*	Minimum Right-of-Way Width
Minor Arterial	25′ with 20′ median	120′
Major Collector	25′ with 11′ median	90′
Minor Collector	45′	70′
Local Street	31′	50′

*Paving on Major Collector and Minor Arterial streets consist of two (2) paving sections with a median.

SECTION 1.6 Street Grades

Arterial and Collector streets may have a maximum grade of seven and one-half (7-1/2) percent. Residential streets may have a maximum grade of ten percent, unless otherwise approved by the City where the natural topography is such as to require steeper grades. All streets must have a minimum grade of at least five-tenths (5/10) of one (1) percent. Centerline grade changes with an algebraic difference of more than one (1) percent shall be connected with vertical curves in compliance with the minimum length requirements set forth in Table 1.7.

Table 1.7

Minimum Length of Vertical Curves - in Feet

Crest Vertical Curves

Algebraic Difference In Grade - Percent	Design Speed 30 MPH	35 MPH	40 MPH
1.0	100	100	100
2.0	100	100	120
3.0	100	120	180
4.0	120	160	240
5.0	150	200	300
6.0	180	240	360
7.0	210	280	420
8.0	240	320	480
9.0	270	360	540
10.0	300	400	600

Sag Vertical Curves

Algebraic Difference In Grade - Percent	Design Speed 30 MPH	35 MPH	40 MPH
1.0	100	100	100
2.0	100	100	120
3.0	120	150	180
4.0	160	200	240
5.0	200	250	300
6.0	240	300	360
7.0	280	350	420
8.0	320	400	480
9.0	360	450	540
10.0	400	500	600